UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

Refer to NMFS No:
WCRO-2020-03569

May 6, 2021

Michelle Walker
Chief, Regulatory Branch
Seattle District, Corps of Engineers PO
Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Port of Kalama Small Cruise Vessel Dock, Corps # NWS-2020-384 Columbia River, Kalama, WA, HUC 170800030306.

Dear Ms. Walker:

Thank you for your letter of November 26, 2019 requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Port of Kalama Small Cruise Vessel Dock project. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

In this opinion, NMFS concludes that the proposed action is not likely to jeopardize the continued existence or result in adverse modification of designated critical habitat for the following species:

- *Oncorhynchus tshawytscha:* Lower Columbia River (LCR) Chinook salmon Upper Willamette River (UWR) Chinook salmon, Upper Columbia River (UCR) spring-run Chinook salmon, Snake River (SR) spring/summer-run Chinook salmon, SR fall-run Chinook salmon,
- *O. kisutch*: LCR coho salmon
- *O. keta*: Columbia River chum salmon
- *O. nerka*: Snake River (SR) sockeye salmon
- *O. mykiss*: LCR steelhead, UWR steelhead, Middle Columbia River steelhead, UCR steelhead, Snake River Basin (SRB) steelhead

We also conclude that the proposed action is not likely to adversely affect the following species and critical habitat:

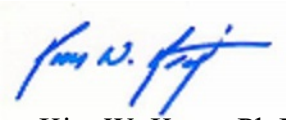
- *Thaleichthys pacificus*: Southern distinct population of eulachon (hereafter referred to as eulachon), and their designated critical habitat
- *Acipenser medirostris:* Southern distinct population of green sturgeon (hereafter referred to as green sturgeon).

As required by section 7 of the Endangered Species Act, the National Marine Fisheries Service provided an incidental take statement with the biological opinion. The incidental take statement describes reasonable and prudent measures the National Marine Fisheries Service considers necessary or appropriate to minimize incidental take associated with this action. The take statement sets forth nondiscretionary terms and conditions. Incidental take from actions that meet the term and condition will be exempt from the Endangered Species Act take prohibition.

NMFS also reviewed the likely effects of the proposed action on essential fish habitat (EFH), pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)), and concluded that the action would adversely affect the EFH of Pacific Coast salmon and Pacific Coast Groundfish. Therefore, we have included the results of that review in Section 3 of this document.

Please contact Scott E. Anderson (scott.anderson@noaa.gov, 360-753-5828) if you have any questions concerning this consultation, or if you require additional information.

Sincerely,



Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

cc: Brad Johnson, USACE

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the

Port of Kalama Small Cruise Vessel Dock
Kalama, Cowlitz County, Washington (NWP-2020-384)

NMFS Consultation Number: WCRO-2020-03569

Action Agency: United States Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	ESA Status	Is Action Likely to Adversely Affect Species?	Is the Action likely to Jeopardize Species?	Is the action likely to adversely affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Lower Columbia River Chinook salmon	T	Yes	No	Yes	No
Upper Willamette River Chinook salmon	T	Yes	No	Yes	No
Upper Columbia River spring-run Chinook salmon	E	Yes	No	Yes	No
Snake River spring/summer run Chinook salmon	T	Yes	No	Yes	No
Snake River fall-run Chinook salmon	T	Yes	No	Yes	No
Columbia River chum salmon	T	Yes	No	Yes	No
Lower Columbia River coho salmon	T	Yes	No	Yes	No
Snake River sockeye salmon	E	Yes	No	Yes	No
Lower Columbia River steelhead	T	Yes	No	Yes	No
Upper Willamette River steelhead	T	Yes	No	Yes	No
Middle Columbia River steelhead	T	Yes	No	Yes	No
Upper Columbia River steelhead	T	Yes	No	Yes	No
Snake River Basin steelhead	T	Yes	No	Yes	No
Southern green sturgeon	T	No	No	N/A	No
Eulachon	T	No	No	No	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

Date: May 6, 2021

TABLE OF CONTENTS

1. INTRODUCTION

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), and implementing regulations at 50 CFR 402, as amended.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file Oregon and Washington Coastal Office.

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on October 28, 2019. We are applying the updated regulations to the consultation. As the preamble to the final rule adopting the regulations noted, "[t]his final rule does not lower or raise the bar on section 7 consultations, and it does not alter what is required or analyzed during a consultation. Instead, it improves clarity and consistency, streamlines consultations, and codifies existing practice." We have reviewed the information and analyses relied upon to complete this biological opinion in light of the updated regulations and conclude the opinion is fully consistent with the updated regulations.

1.2 Consultation History

On November 6, 2020, The U.S. Army Corps of Engineers (Corps) submitted materials for concurrence that their permit would comply with Standard Local Operating Procedure for Endangered Species (SLOPES) Programmatic Opinion, (2011/05585). However, in early December 2020, we denied the use of SLOPES for this project because SLOPES specifies piles no larger than 24-inches in diameter. The proposed, 36-inch diameter breasting piles exceed that limit, and we informed the Corps and the Port of Kalama that formal consultation for this project would be required.

On December 21, 2020, the Corps submitted materials for formal consultation. We initiated formal consultation on January 4, 2021.

Proposed Federal Action

The Port of Kalama seeks section 404 and 401 permits from the Corps for construction a new pier, ramp, and float (small cruise vessel dock) to service small cruise vessels. The proposed small cruise vessel dock would be elevated above the water, with no floating portion. New structures would include a landing area, gangway, and tower to provide an adjustable lift to allow gangway access between the shore and vessel at any river level.

In-Water and Overwater Areas

Gangways
Gangways (11.5 feet wide) will connect the vessel to the shoreline in two sections. A 70-foot-long fixed gangway will extend from the landing to an intermediate support pier, and a 120-foot-long adjustable gangway will extend from the intermediate support pier to the tower frame that adjusts the gangway elevation to the vessel-provided, short-transfer span gangway. This would allow vessel access at different river levels. The two gangways will be 100% grated with fiber-reinforced polymer (FRP) grating. The total overwater coverage of these gangways is 1,976 square feet.

Intermediate Support Pier and Tower Pier
The intermediate support pier will be 14.5 feet wide by 4.5 feet (65 square feet) and will be a pre-cast concrete cap supported by one 24-inch diameter, steel-pipe vertical pile. The tower-support pier will include two pre-cast concrete caps 11 feet wide by 6 feet (132 square feet) supported by two 36-inch diameter, steel-pipe piles. The tower frame will consist of steel and will support a lift table adjusted by a screw jack that will raise this portion of the adjustable gangway to meet the vessel's gangway. This configuration would be adjustable to different river levels.

Mooring Dolphins
Mooring dolphins will be installed to secure the vessel while they are moored. Six, 36-inch pipe piles with pile caps and bollards to secure the mooring lines would include 8-foot-diameter floating donut fenders.

Pile driving and orphan pile removal are the only proposed in-water work, which will take a total of approximately 11 days during the in-water work window between October 1 and December 31. The remaining work will be conducted out of the water and will occur after piles have been installed, which could occur during any time of the year. Pile driving will be accomplished from a barge with a pile driving crane. The project would also remove 11 existing derelict wood piles from a nearby nearshore area using a vibratory extractor.

Pile Installation
This project will install eight, 36-inch steel pipe piles and one, 24-inch, steel pipe pile below Ordinary High Water Mark (OHWM). Installing these piles with vibratory pile driving from a crane barge is estimated to occur intermittently over a period of 11 days. Dolphin piles (36-inch diameter steel pipe piles) will be driven primarily using a vibratory hammer. These piles will be driven up to 90 feet below existing mudline, using the vibratory hammer. It is anticipated that installation of the dolphin piles will require approximately one hour to 90 minutes of vibratory driving per pile. An impact hammer may be needed to complete installation of these piles if the

vibratory hammer is unable to advance the piles to the final required embedment. If an impact hammer is needed to complete pile driving, the project proponent estimates this will require up to 1,000 blows per pile for an estimated 30 minutes of continuous driving.

Bearing piles (two 36-inch and one 24-inch diameter steel pipe piles) will be driven with both vibratory and impact hammers. These piles will be driven up to 100 feet below existing mudline. A vibratory hammer will be used to advance the piles to within 10 feet of final design tip elevation, at which time an impact hammer will be used to drive the final 10 feet and obtain bearing capacity (proof pile). It is anticipated that bearing-pile installation will require approximately one hour to 90 minutes of vibratory driving and 30 minutes of continuous impact driving per pile to complete installation. Assuming only the final 10 feet of pile needs to be impact driven, the project proponent estimates this will require an estimated 1,000 blows per pile over the 30 minute period.

A soft-start technique will be used for both vibratory and impact-hammer pile driving to allow aquatic species to leave the work area before full energy is used to drive pile. For vibratory pile driving, the contractor will initiate noise for 15 seconds at 40 to 60 percent reduced energy, followed by a 1-minute waiting period. This procedure will be repeated two additional times before full energy is applied. The soft-start procedure will be conducted prior to driving each pile if vibratory installation stops for more than 30 minutes. For impact driving, the contractor will be required to use an initial set of three strikes at 40 percent energy, followed by a 1-minute waiting period, then two subsequent three-strike sets (NMFS 2012). Using the Practical Spreading Loss model, the farthest distance that impact-hammer pile driving noise with a bubble curtain will attenuate to background levels when compared to the highest predicted dBpeak level with attenuation from the 36-inch piles: 10 meters * $10^{((205-140)/15)}$=706,655 feet = 133 miles. Underwater noise is assumed to extend in a linear manner and not bend around land masses, so the impacted area is determined by drawing straight lines from the pile driving areas to the nearest land mass. Therefore, area of river affected extends downstream about 2 miles and extends upstream about 3 miles (figure 1).

A soft-start technique will be used for both vibratory and impact-hammer pile driving to allow aquatic species to leave the work area before full energy is used to drive piling. For vibratory pile driving, the contractor will initiate noise for 15 seconds at 40 to 60 percent reduced energy, followed by a 1-minute waiting period. This procedure will be repeated two additional times before full energy is applied. The soft-start procedure will be conducted prior to driving each pile if vibratory installation stops for more than 30 minutes. For impact driving, the contractor will be required to use an initial set of three strikes at 40 percent energy, followed by a 1-minute waiting period, then two subsequent three-strike sets (NMFS 2012).

Impact Avoidance and Minimization Measures

The project has been designed to avoid and minimize impacts to habitats and species that may potentially occur in the vicinity of the project area. This will be accomplished by using the following measures:

- The crane barge will not “ground out” at any time.
- Contractors will have a spill containment and pollution control plan, and their employees will be trained in its implementation.

- The contractor will have an oil-absorbing floating boom onboard.
- No debris will be allowed to enter the river from the barge, boats associated with construction, or moored boats.
- New piles will be installed using a vibratory hammer. If vibratory driving cannot drive piles to design depths, an impact hammer will be used. Proofing with an impact hammer will only occur on the load-bearing piles and may only be needed on one pile to determine the necessary tip elevation that provides the required load-bearing capacity.
- Pile driving with an impact hammer to proof piles will take place within a confined bubble curtain.
- A soft-start technique will be used for vibratory and impact-hammer pile driving to allow aquatic species to leave the work area before full energy is used to drive the pile.
- Pile caps will be installed on all piling associated with this project to prevent bird perching.

Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910). We considered whether or not the proposed action would cause any other activities and determined that it would cause other activities, which are the traffic of small cruise vessels to and from the new pier, ramp and float.

1.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The action area includes the Columbia River and an area up and downstream of the project site where elevated sound levels will emanate from impact pile driving. As such, we consider an area (Figure 1) approximately 5 miles in length (2 miles downstream, 3 miles upstream), encompassing the entire river within the 5 miles, as the action area. This area also encompasses the suspended sediment (turbidity) plume expected during pile installation and removal. Effects associated with vessel traffic to and from the new dock would also occur within this action area, and while vessels could transit beyond the action area, the intensity of that traffic and its effects cannot be accurately anticipated beyond the action area. The action area contains CH for all salmonids, and eulachon, but not for green sturgeon. EFH for Pacific salmonids is also in the action area.

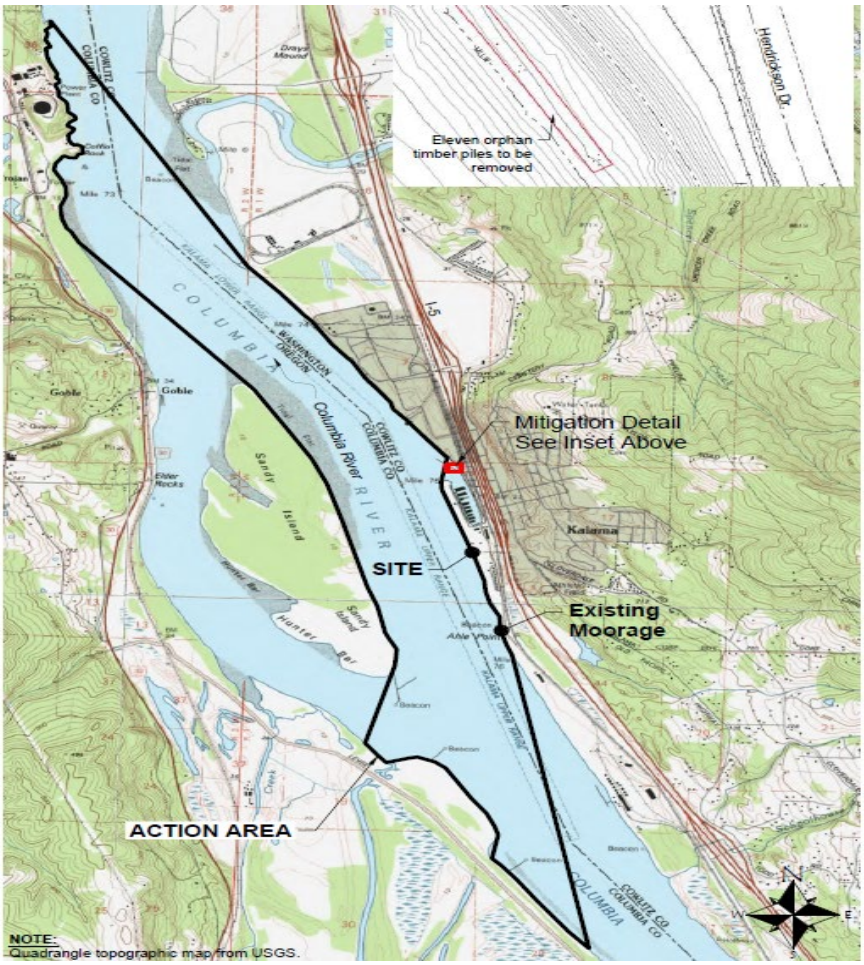


Figure 1. Approximated Action area as defined (in black polygon) by extent of elevated underwater sound exposure levels from pile driving

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the essential PBFs that help to form that conservation value.

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014, Mote 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013, Mote et al. 2014).

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014; Kunkel et al. 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014). Decreases in summer precipitation of as much as 30 percent by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013; Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in

dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Winder and Schindler 2004, Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7^{o}C by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011, Reeder et al. 2013).

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. Acidification also impacts sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012, Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching likely predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011, Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007).

Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011, Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will likely intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

2.2.1 Status of Critical Habitat

Table 1. Critical Habitat designations and critical habitat status for species with critical habitat considered in this opinion.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Lower Columbia River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 47 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some, or high potential for improvement. We rated conservation value of HUC5 watersheds as high for 30 watersheds, medium for 13 watersheds, and low for four watersheds.
Upper Columbia River spring-run Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses four subbasins in Washington containing 15 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. We rated conservation value of HUC5 watersheds as high for 10 watersheds, and medium for five watersheds. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Snake River spring/summer-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers (except the Clearwater River) presently or historically accessible to this ESU (except reaches above impassable natural falls and Hells Canyon Dam). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Willamette River Chinook salmon	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Oregon containing 56 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some, or high, potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 22 watersheds, medium for 16 watersheds, and low for 18 watersheds.
Snake River fall-run Chinook salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers, and all tributaries of the Snake and Salmon rivers presently or historically accessible to this ESU (except reaches above impassable natural falls, and Dworshak and Hells Canyon dams). Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Columbia River chum salmon	9/02/05 70 FR 52630	Critical habitat encompasses six subbasins in Oregon and Washington containing 19 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 16 watersheds, and medium for three watersheds.
Lower Columbia River coho salmon	2/24/16 81 FR 9252	Critical habitat encompasses 10 subbasins in Oregon and Washington containing 55 occupied watersheds, as well as the lower Columbia River and estuary rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 34 watersheds, medium for 18 watersheds, and low for three watersheds.
Snake River sockeye salmon	10/25/99 64 FR 57399	Critical habitat consists of river reaches of the Columbia, Snake, and Salmon rivers; Alturas Lake Creek; Valley Creek; and Stanley, Redfish, Yellow Belly, Pettit and Alturas lakes (including their inlet and outlet creeks). Water quality in all five lakes generally is adequate for juvenile sockeye salmon, although zooplankton numbers vary considerably. Some reaches of the Salmon River and tributaries exhibit temporary elevated water temperatures and sediment loads that could restrict sockeye salmon production and survival (NMFS 2015b). Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Upper Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 10 subbasins in Washington containing 31 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 20 watersheds, medium for eight watersheds, and low for three watersheds.
Lower Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses nine subbasins in Oregon and Washington containing 41 occupied watersheds, as well as the lower Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of HUC5 watersheds as high for 28 watersheds, medium for 11 watersheds, and low for two watersheds.
Upper Willamette River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses seven subbasins in Oregon containing 34 occupied watersheds, as well as the lower Willamette/Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. Watersheds are in good to excellent condition with no potential for improvement only in the upper McKenzie River and its tributaries (NMFS 2005). We rated conservation value of HUC5 watersheds as high for 25 watersheds, medium for 6 watersheds, and low for 3 watersheds.
Middle Columbia River steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 15 subbasins in Oregon and Washington containing 111 occupied watersheds, as well as the Columbia River rearing/migration corridor. Most HUC5 watersheds with PCEs for salmon are in fair-to-poor or fair-to-good condition (NMFS 2005). However, most of these watersheds have some or a high potential for improvement. We rated conservation value of occupied HUC5 watersheds as high for 80 watersheds, medium for 24 watersheds, and low for 9 watersheds.

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Snake River basin steelhead	9/02/05 70 FR 52630	Critical habitat encompasses 25 subbasins in Oregon, Washington, and Idaho. Habitat quality in tributary streams varies from excellent in wilderness and roadless areas, to poor in areas subject to heavy agricultural and urban development (Wissmar et al. 1994). Reduced summer stream flows, impaired water quality, and reduced habitat complexity are common problems. Migratory habitat quality in this area has been severely affected by the development and operation of the dams and reservoirs of the Federal Columbia River Power System.
Southern DPS of eulachon	10/20/11 76 FR 65324	Critical habitat for eulachon includes portions of 16 rivers and streams in California, Oregon, and Washington. All of these areas are designated as migration and spawning habitat for this species. In Oregon, we designated 24.2 miles of the lower Umpqua River, 12.4 miles of the lower Sandy River, and 0.2 miles of Tenmile Creek. We also designated the mainstem Columbia River from the mouth to the base of Bonneville Dam, a distance of 143.2 miles. Dams and water diversions are moderate threats to eulachon in the Columbia and Klamath rivers where hydropower generation and flood control are major activities. Degraded water quality is common in some areas occupied by southern DPS eulachon. In the Columbia and Klamath river basins, large-scale impoundment of water has increased winter water temperatures, potentially altering the water temperature during eulachon spawning periods. Numerous chemical contaminants are also present in spawning rivers, but the exact effect these compounds have on spawning and egg development is unknown. Dredging is a low to moderate threat to eulachon in the Columbia River. Dredging during eulachon spawning would be particularly detrimental.

2.2.2 Status of the Species

Table 2, below provides a summary of listing and recovery plan information, status summaries and limiting factors for many of the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species. These documents are available on the NMFS West Coast Region website (http://www.westcoast.fisheries.noaa.gov/). Acronyms appearing in the table include DPS (Distinct Population Segment), ESU (Evolutionarily Significant Unit), ICTRT (Interior Columbia Technical Recovery Team), MPG (Multiple Population Grouping), NWFSC (Northwest Fisheries Science Center), TRT (Technical Recovery Team), and VSP (Viable Salmonid Population).

Table 2. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for fish species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River Chinook salmon	Threatened 6/28/05	NMFS 2013	NWFSC 2015	This ESU comprises 32 independent populations. Twenty-seven populations are at very high risk, 2 populations are at high risk, one population is at moderate risk, and 2 populations are at very low risk Overall, there was little change since the last status review in the biological status of this ESU, although there are some positive trends. Increases in abundance were noted in about 70% of the fall-run populations and decreases in hatchery contribution were noted for several populations. Relative to baseline VSP levels identified in the recovery plan, there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals.	• Reduced access to spawning and rearing habitat • Hatchery-related effects • Harvest-related effects on fall Chinook salmon • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Contaminant
Upper Columbia River spring-run Chinook salmon	Endangered 6/28/05	Upper Columbia Salmon Recovery Board 2007	NWFSC 2015	This ESU comprises four independent populations. Three are at high risk and one is functionally extirpated. Current estimates of natural origin spawner abundance increased relative to the levels observed in the prior review for all three extant populations, and productivities were higher for the Wenatchee and Entiat populations and unchanged for the Methow population. However, abundance and productivity remained well below the viable thresholds called for in the Upper Columbia Recovery Plan for all three populations.	• Effects related to hydropower system in the mainstem Columbia River • Degraded freshwater habitat • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Persistence of non-native (exotic) fish species • Harvest in Columbia River fisheries

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River spring/summer-run Chinook salmon	Threatened 6/28/05	NMFS 2017a	NWFSC 2015	This ESU comprises 28 extant and four extirpated populations. All expect one extant population (Chamberlin Creek) are at high risk. Natural origin abundance has increased over the levels reported in the prior review for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in recent years were a major factor in recent abundance patterns. While there have been improvements in abundance and productivity in several populations relative to prior reviews, those changes have not been sufficient to warrant a change in ESU status.	• Degraded freshwater habitat • Effects related to the hydropower system in the mainstem Columbia River, • Altered flows and degraded water quality • Harvest-related effects • Predation

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River Chinook salmon	Threatened 6/28/05	NMFS 2011	NWFSC 2015	This ESU comprises seven populations. Five populations are at very high risk, one population is at moderate risk (Clackamas River) and one population is at low risk (McKenzie River). Consideration of data collected since the last status review in 2010 indicates the fraction of hatchery origin fish in all populations remains high (even in Clackamas and McKenzie populations). The proportion of natural origin spawners improved in the North and South Santiam basins, but is still well below identified recovery goals. Abundance levels for five of the seven populations remain well below their recovery goals. Of these, the Calapooia River may be functionally extinct and the Molalla River remains critically low. Abundances in the North and South Santiam rivers have risen since the 2010 review, but still range only in the high hundreds of fish. The Clackamas and McKenzie populations have previously been viewed as natural population strongholds, but have both experienced declines in abundance despite having access to much of their historical spawning habitat. Overall, populations appear to be at either moderate or high risk, there has been likely little net change in the VSP score for the ESU since the last review, so the ESU remains at moderate risk.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats • Altered food web due to reduced inputs of microdetritus • Predation by native and non-native species, including hatchery fish • Competition related to introduced salmon and steelhead • Altered population traits due to fisheries and bycatch

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River fall-run Chinook salmon	Threatened 6/28/05	NMFS 2017ba	NWFSC 2015	This ESU has one extant population. Historically, large populations of fall Chinook salmon spawned in the Snake River upstream of the Hells Canyon Dam complex. The extant population is at moderate risk for both diversity and spatial structure and abundance and productivity. The overall viability rating for this population is 'viable.' Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of 'viable' developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.	• Degraded floodplain connectivity and function • Harvest-related effects • Loss of access to historical habitat above Hells Canyon and other Snake River dams • Impacts from mainstem Columbia River and Snake River hydropower systems • Hatchery-related effects • Degraded estuarine and nearshore habitat.
Columbia River chum salmon	Threatened 6/28/05	NMFS 2013	NWFSC 2015	Overall, the status of most chum salmon populations is unchanged from the baseline VSP scores estimated in the recovery plan. A total of 3 of 17 populations are at or near their recovery viability goals, although under the recovery plan scenario these populations have very low recovery goals of 0. The remaining populations generally require a higher level of viability and most require substantial improvements to reach their viability goals. Even with the improvements observed during the last five years, the majority of populations in this ESU remain at a high or very high risk category and considerable progress remains to be made to achieve the recovery goals.	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Degraded stream flow as a result of hydropower and water supply operations • Reduced water quality • Current or potential predation • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River coho salmon	Threatened 6/28/05	NMFS 2013	NWFSC 2015	Of the 24 populations that make up this ESU, 21 populations are at very high risk, 1 population is at high risk, and 2 populations are at moderate risk. Recent recovery efforts may have contributed to the observed natural production, but in the absence of longer term data sets it is not possible to parse out these effects. Populations with longer term data sets exhibit stable or slightly positive abundance trends. Some trap and haul programs appear to be operating at or near replacement, although other programs still are far from that threshold and require supplementation with additional hatchery-origin spawners .Initiation of or improvement in the downstream juvenile facilities at Cowlitz Falls, Merwin, and North Fork Dam are likely to further improve the status of the associated upstream populations. While these and other recovery efforts have likely improved the status of a number of coho salmon populations, abundances are still at low levels and the majority of the populations remain at moderate or high risk. For the Lower Columbia River region land development and increasing human population pressures will likely continue to degrade habitat, especially in lowland areas. Although populations in this ESU have generally improved, especially in the 2013/14 and 2014/15 return years, recent poor ocean conditions suggest that population declines might occur in the upcoming return years	• Degraded estuarine and near-shore marine habitat • Fish passage barriers • Degraded freshwater habitat: Hatchery-related effects • Harvest-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River sockeye salmon	Endangered 6/28/05	NMFS 2015	NWFSC 2015	This single population ESU is at very high risk dues to small population size. There is high risk across all four basic risk measures. Although the captive brood program has been successful in providing substantial numbers of hatchery produced fish for use in supplementation efforts, substantial increases in survival rates across all life history stages must occur to re-establish sustainable natural production In terms of natural production, the Snake River Sockeye ESU remains at extremely high risk although there has been substantial progress on the first phase of the proposed recovery approach – developing a hatchery based program to amplify and conserve the stock to facilitate reintroductions.	• Effects related to the hydropower system in the mainstem Columbia River • Reduced water quality and elevated temperatures in the Salmon River • Water quantity • Predation
Upper Columbia River steelhead	Threatened 1/5/06	Upper Columbia Salmon Recovery Board 2007	NWFSC 2015	This DPS comprises four independent populations. Three populations are at high risk of extinction while 1 population is at moderate risk. Upper Columbia River steelhead populations have increased relative to the low levels observed in the 1990s, but natural origin abundance and productivity remain well below viability thresholds for three out of the four populations. The status of the Wenatchee River steelhead population continued to improve based on the additional year's information available for the most recent review. The abundance and productivity viability rating for the Wenatchee River exceeds the minimum threshold for 5% extinction risk. However, the overall DPS status remains unchanged from the prior review, remaining at high risk driven by low abundance and productivity relative to viability objectives and diversity concerns.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded floodplain connectivity and function, channel structure and complexity, riparian areas, large woody debris recruitment, stream flow, and water quality • Hatchery-related effects • Predation and competition • Harvest-related effects

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Lower Columbia River steelhead	Threatened 1/5/06	NMFS 2013	NWFSC 2015	This DPS comprises 23 historical populations, 17 winter-run populations and six summer-run populations. Nine populations are at very high risk, 7 populations are at high risk, 6 populations are at moderate risk, and 1 population is at low risk. The majority of winter-run steelhead populations in this DPS continue to persist at low abundances. Hatchery interactions remain a concern in select basins, but the overall situation is somewhat improved compared to prior reviews. Summer-run steelhead populations were similarly stable, but at low abundance levels. The decline in the Wind River summer-run population is a source of concern, given that this population has been considered one of the healthiest of the summer-runs; however, the most recent abundance estimates suggest that the decline was a single year aberration. Passage programs in the Cowlitz and Lewis basins have the potential to provide considerable improvements in abundance and spatial structure, but have not produced self-sustaining populations to date. Even with modest improvements in the status of several winter-run DIPs, none of the populations appear to be at fully viable status, and similarly none of the MPGs meet the criteria for viability.	• Degraded estuarine and nearshore marine habitat • Degraded freshwater habitat • Reduced access to spawning and rearing habitat • Avian and marine mammal predation • Hatchery-related effects • An altered flow regime and Columbia River plume • Reduced access to off-channel rearing habitat in the lower Columbia River • Reduced productivity resulting from sediment and nutrient-related changes in the estuary • Juvenile fish wake strandings • Contaminants

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Upper Willamette River steelhead	Threatened 1/5/06	NMFS 2011	NWFSC 2015	This DPS has four demographically independent populations. Three populations are at low risk and one population is at moderate risk. Declines in abundance noted in the last status review continued through the period from 2010-2015. While rates of decline appear moderate, the DPS continues to demonstrate the overall low abundance pattern that was of concern during the last status review. The causes of these declines are not well understood, although much accessible habitat is degraded and under continued development pressure. The elimination of winter-run hatchery release in the basin reduces hatchery threats, but non-native summer steelhead hatchery releases are still a concern for species diversity and a source of competition for the DPS. While the collective risk to the persistence of the DPS has not changed significantly in recent years, continued declines and potential negative impacts from climate change may cause increased risk in the near future.	• Degraded freshwater habitat • Degraded water quality • Increased disease incidence • Altered stream flows • Reduced access to spawning and rearing habitats due to impaired passage at dams • Altered food web due to changes in inputs of microdetritus • Predation by native and non-native species, including hatchery fish and pinnipeds • Competition related to introduced salmon and steelhead • Altered population traits due to interbreeding with hatchery origin fish
Middle Columbia River steelhead	Threatened 1/5/06	NMFS 2009b	NWFSC 2015	This DPS comprises 17 extant populations. The DPS does not currently include steelhead that are designated as part of an experimental population above the Pelton Round Butte Hydroelectric Project. Returns to the Yakima River basin and to the Umatilla and Walla Walla Rivers have been higher over the most recent brood cycle, while natural origin returns to the John Day River have decreased. There have been improvements in the viability ratings for some of the component populations, but the DPS is not currently meeting the viability criteria in the MCR steelhead recovery plan. In general, the majority of population level viability ratings remained unchanged from prior reviews for each major population group within the DPS.	• Degraded freshwater habitat • Mainstem Columbia River hydropower-related impacts • Degraded estuarine and nearshore marine habitat • Hatchery-related effects • Harvest-related effects • Effects of predation, competition, and disease

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Snake River basin steelhead	Threatened 1/5/06	NMFS 2017a	NWFSC 2015	This DPS comprises 24 populations. Two populations are at high risk, 15 populations are rated as maintained, 3 populations are rated between high risk and maintained, 2 populations are at moderate risk, 1 population is viable, and 1 population is highly viable. Four out of the five MPGs are not meeting the specific objectives in the draft recovery plan based on the updated status information available for this review, and the status of many individual populations remains uncertain A great deal of uncertainty still remains regarding the relative proportion of hatchery fish in natural spawning areas near major hatchery release sites within individual populations.	• Adverse effects related to the mainstem Columbia River hydropower system • Impaired tributary fish passage • Degraded freshwater habitat • Increased water temperature • Harvest-related effects, particularly for B-run steelhead • Predation • Genetic diversity effects from out-of-population hatchery releases
					•

2.3 Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

The action area is located in a portion of the mainstem of the Lower Columbia River that is tidally influenced, and its current conditions is influenced by multiple factors occurring upstream and upland, in addition to features of the specific site. Historically, the mainstem LCR was less than 20 feet deep, and supported vegetated wetlands within the floodplain that supplied the estuary with an abundance of macrodetritus, the base-level food source for juvenile salmonids (NMFS 2011a). Subsequent modifications to the LCR have reduced the quality, amount, and accessibility of habitat, resulting from diking, dredging, and filling for agricultural, urban, industrial, and hydroregulation for power generation and flood control activities. Regulation of river flow has reduced spring freshet flows to about 50% of the natural level, and has increased fall minimum flows by 10 to 50% (Simenstad et al. 1992). As a result of flow regulation, increased nutrients, increased water clarity and temperature. The current base-level food source in the LCR consists of microdetritus, such as phytoplankton and zooplankton transported from areas throughout the Columbia watershed (Sherwood et al 1990; Weitkamp 1994). Nearly all emergent aquatic vegetation in the LCR is located in tidal swamps near brackish water areas (Weitkamp 1994). The action area is located in a reach of the Columbia River with rapid flow and coarse sand and does not support the presence, nor establishment of submerged aquatic vegetation.

The combined effects of water withdrawals for irrigation, hydroregulation, electricity production, diking, and filling have reduced the surface area of the estuary by approximately 20 percent over the past 200 years, resulting in decreased access to up to 77 percent of historical tidal swamps and peripheral wetlands (Fresh et al. 2005). Currently a lack of habitat and reduced habitat quality are identified as factors limiting viability of salmonids in the mainstem LCR (NMFS 2011b). Overbank flooding that normally would aid juveniles in accessing off-channel refugia and food resources has been virtually eliminated, and sediment transport processes that build habitat and constitute refugia habitat have been impaired (NMFS 2011a). Bottom et al. (2005) noted the near complete elimination of overbank flood events in the LCR and the separation of the river from its floodplain, both conditions that have altered the food web by reducing macrodetrital inputs by approximately 84 percent. Currently, phytoplankton detrital sources from upstream reservoirs now dominate the base of the food chain. This change from a food web based on macrodetritus to one based on microdetritus has profound effects on the estuary ecosystem to support migration and rearing of juvenile salmonids.

Upstream dams have prevented sediments from entering the estuary, while dredging activities have increasingly deepened the channel and exported sand and gravel out of the estuary. Since the late nineteenth century, sediment transport from the interior basin to the Columbia River estuary has decreased about 60 percent and total sediment transport has decreased about 70 percent (Jay and Kukulka 2003). Currently, sand is exported from the estuary at a rate approximately three times higher than that at which it enters the estuary. The full impact of these changes is unknown; however, sediment transport is a primary habitat-shaping force that determines the type, location, and availability of habitats distributed in the estuary and plume. It is thought that reductions in the amount of fine sediment have increased water clarity, allowing avian and aquatic predators to more easily locate and consume salmonids during both adult and juvenile life stages. The increasing simplification of habitat characteristics of the river have reduced the variety of life history expressions documented one hundred years ago by W.H. Rich (1920).

Toxic contaminants are widespread in the estuary, both geographically and in the food chain, with the urban and industrial portions of the estuary contributing significantly to juvenile salmon's toxic load (LCREP 2007). Some of these contaminants are water-soluble agricultural pesticides and fertilizers, such as simazine, atrazine, and diazinon, and copper-based chemicals (Hecht et al. 2007). Industrial contaminants include polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Also present are pharmaceuticals, personal care products, brominated fire retardants, and other emerging contaminants. Concentrations of toxic contaminants in the bodies of juvenile salmonids in the estuary sometimes are above levels estimated to cause health effects. In a 2007 study, this was the case for PCBs, PAHs, and DDT, and juveniles showed evidence of exposure to hormone-disrupting compounds (LCREP 2007). Salmon and steelhead experience both short-term exposure to toxic substances and long-term exposure to contaminants that accumulate over time and magnify through the food chain. Even when exposures are sublethal, they can cause significant developmental, behavioral, health, and reproductive impairments.

The LCR is has become a central point of economic growth, particularly in areas between Longview, Washington and Portland, Oregon. Marine terminal facilities at the ports of Longview, Kalama, Portland, Vancouver, and Woodland dominate use of shorelines on the Columbia River. EPA identified 49 different chemicals of emerging concern in sediments in the lower Columbia River main stem and several tributaries. Endocrine-disrupting compounds (contaminants that block or mimic hormones in the body and cause harm to fish and wildlife) were detected at 22 of 23 sites sampled (EPA 2014).

Individual from all 15 species use the action area for migration (both as adults and as juveniles) and some species use the action area for juvenile rearing as well. Rearing species are exposed to the array of poor baseline conditions longer, which may make them more susceptible to effects of the proposed action.

2.4 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are

caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

Effects of the proposed action include:

- Underwater sound, from both vibratory and impact pile driving, attenuated by employing a bubble curtain (noise);
- Vessel traffic and use during construction, and recreational vessel use post construction, (noise, shade, sediment disturbance, and water pollution); and
- Diminishment of critical habitat quality through the placement of the overwater structure and attendant piles (shade, piscivore habitat, prey reduction).

2.4.1 Effects on Critical Habitat

Critical habitat includes Physical and Biological Features (PBFs) necessary to support various life stages of salmonid and non-salmonid listed fish (i.e, rearing, migration), including good water quality, appropriate substrate, good riparian conditions, and sufficient prey, and safe migration. Critical habitat is not designated for Green Sturgeon in the action area.

Shade – Shade has two effects on features of habitat: 1) it can promote conditions for piscivorous fishes, and 2) can reduce subaquatic plant and prey communities. These habitat effects can diminish migration and rearing conditions.

The proposed gangway will be fully grated and is elevated 15 feet above MLLW and 11 feet above OHWM. Because of its elevation and grated features indirect light can reach the water below the structure in most circumstances. Shade directly underneath the structure will only occur intermittently, when the sun is directly above the structure in summer months. The tower frame and piles with 6-foot x 11-foot caps will produce two 132 sf shaded areas. The vessels will create shade when they are moored from March to mid-November. Depths where vessels will be moored is 20-30 feet.

Predation: Shading from moored vessels (construction or recreational) could create predator habitat where juvenile salmonids, particularly ocean-type juvenile salmon (primarily fall Chinook and chum), migrate, when present, however because vessels are not permanently stationed, and the presence of vessels will occur over water at depths of 20 to 30 feet, where light penetration is already low.

Prey Reduction: The float where the vessels docked are is in a fixed location, however we expect this effect to be minimal because the structure will be placed 15 feet above MLLW and 11 feet above MHHW at the lowest adjustable gangway level, creating angled, diffuse shade that will occur directly underneath the structure for short periods during the summer. For these reasons the shade is intermittent, and shade effects on aquatic plant and prey communities, including planktonic prey, is expected to be minor.

Rearing values – Shade and predator habitat from piles also decrease the capacity of the habitat for rearing fish similarly to the reductions described for migration. Risk of predation increases, prey communities and natural cover decrease, and shaded areas are generally avoided by juveniles (salmonids) so we expect a localized reduction in optimum rearing conditions is likely.

Shading and piles will have no effect on adult eulachon migration values because the structure will not impede migration or spawning for larval eulachon which drift passively to the estuary. Therefore, shading and piles will have negligible effects on eulachon, or designated critical habitat for eulachon.

Noise – Fish can detect and respond to sound from pile driving and from vessel motors in a manner that delays their migratory behavior and makes them more susceptible to predators. For the period of time that vibratory driving, impact driving, or vessel noise occurs, the migration value of the action area is diminished, but these are each temporary occurrences that do not prevent the action area from serving its migration role. The use of a bubble curtain during impact driving constrains the greatest impairment to safe migration to a relatively small subset within the action area.

Rearing values – Elevated noise from pile driving will temporarily adversely affect the rearing PBF for salmonid critical habitat. Once pile driving is completed, rearing values will be affected by the presence of the structure.

Predation - After the construction period, all juvenile species of salmon and steelhead could occur near the proposed piles while migrating downriver, and be vulnerable to fish predators using the piles for ambushing migrating juveniles. Adult migration will not be affected by the proposed structures. The presence of proposed piles will likely adversely affect juvenile salmon and steelhead the safe migration value of designated critical habitat in the action area.

Water Pollution – water quality may temporarily reduced in the areas adjacent to and downstream of pile installation, pile removal, when bottom substrates become disturbed/suspended. These effects are primarily localized as sands and coarse materials settle quickly (minutes to hours) and finer materials disperse on downstream currents, typically indistinguishable from background turbidity levels beyond 300 feet downstream. Suspended sediment will be episodic, occurring one time in the location where project installation occurs, and one time where the mitigation removal of piles occurs,

Vessels are also a chronic but minor source of water quality reductions when fuels, oils, and exhaust enter the water.

Migration values are unlikely to be appreciably diminished by these sources of water quality reduction, however rearing values could be incrementally and chronically diminished by the chemical contaminants reducing prey communities or creating a source for bioaccumulation. Also, growth and fitness values of rearing could be diminished a result. This effect is discussed more fully in effects on listed fish, below.

2.4.2 Effects on listed fishes

Effects on listed species is a function of exposure and response. We evaluate project effects at the at the individual scale, then translate those effects up to the population scale by determining if effects to individual fish occur at such a level that they will negatively influence viability salmonid population (VSP) characteristics of exposed populations (e.g, do abundance reductions create reductions in productivity, diversity, or spatial structure).

Because peak presence of most migrating juvenile fish is avoided by the work timing as well as the minimization measures described in the BA, most exposure and response is likely to occur among those species with rearing behaviors in the action area, such as juvenile LCR coho, LCR and Willamette River Chinook salmon, and LCR and Willamette River steelhead and SR fall Chinook salmon. Adult fish are also not present during the work window, with the exception of chum and coho that are returning to spawn. These six species will be exposed to the habitat effects described above – noise, water quality reductions, shade, reduced prey, and increased predation. However, adult response is very different to these effects than juvenile response.

Noise -As discussed above the most acute of effects of the action will occur among juvenile LCR coho, LCR and Willamette River Chinook salmon, LCR and Willamette River steelhead and SR fall Chinook salmon, as well as adult chum and coho salmon. Each of these species will be in the action area and will experience elevated noise during impact pile driving. All impact pile work will be conducted over an eleven day period from October 1 through December 31. All piles will initially be installed via vibratory hammer, followed by proofing with an impact hammer with sound attenuation strategies including the use of bubble curtains. Acoustic disturbances associated with pile driving are likely to disrupt the foraging behavior and reduce forage efficiency of juvenile salmonids. Biological effects to ESA-listed salmonids may also result from the high sound pressures produced when the piles are proofed with an impact hammer.

Fishes with swimbladders (including salmonids) are sensitive to underwater impulsive sounds, i.e., sounds with a sharp sound pressure peak occurring in a short interval of time (Rodkin and Pomerenck, 2014). As the pressure wave passes through a fish, the swimbladder is rapidly squeezed due to the high pressure, and then rapidly expanded as the under pressure component of the wave passes through the fish. The pneumatic pounding may rupture capillaries in the internal organs as indicated by observed blood in the abdominal cavity, and maceration of the kidney tissues (Rodkin and Pomerenck, 2014). The injuries caused by such pressure waves are known as barotraumas, and include hemorrhage and rupture of internal organs, as described above, and damage to the auditory system. Death can be instantaneous, can occur within minutes after exposure, or can occur several days later. A multi-agency work group determined that to protect listed species, sound pressure waves should be within a single strike threshold of 206 decibels (dB), and for cumulative strikes either 187 dB sound exposure level (SEL) where fish are larger than 2 grams or 183 dB SEL where fish are smaller than 2 grams. The SEL measurement is a cumulative measurement, based on the number of consecutive strikes, where the SEL increases as pile strikes increase in number. When many consecutive pile strikes are needed, Stadler (pers comm 5-18-19) states that cessation of pile driving for 10-12 hours after multiple strikes before resuming pile driving reduces SELs to baseline and can provide fish an opportunity to move

through the area and away from the impacted pile, reducing effects of SELs on fish. The project proponent estimates impact pile driving will require up to 1,000 blows per pile for an estimated 30 minutes of continuous driving per pile. The number of blow counts is expected to be highly variable from day to day and dependent largely on the equipment used and geologic conditions encountered in a given area.

Based on this information, we conservatively estimate cumulative SEL at approximately 208 dB based on 9,000 strikes per day (9 piles x 1,000 strikes). This dB could increase if more than 9,000 strikes occur in one day. As such, death or injury of individual fish is likely to occur among any juvenile salmonids that may be migrating through or rearing in the five mile action area.

Deployment of a bubble curtain is expected to attenuate the peak sound pressure levels by approximately 7-9 dB. As such, a bubble curtain may not bring the sound pressure levels below biological thresholds, and some death or injuries of ESA-listed salmonids are still likely to occur. Even with the use of the bubble curtain, adverse effects to salmonids are expected in the vicinity of the pile driving. Yelverton et al. (1975) found a direct correlation between smaller body mass and the magnitude of injuries and mortalities from underwater blasts. The October through December pile driving work window minimizes the likelihood that small juvenile fish would co-occur with elevated SELs from pile driving because peak migration is avoided. Rearing juveniles have the greatest likelihood of exposure/response.

Adult salmonids would almost all be absent and avoid exposure based on the work window, however CR chum and LCR coho are likely to be present, potentially in significant numbers, as they return to their natal streams. Because CR chum and LCR coho would be adult fish, they would likely move away from the area at the onset of pile driving. As such, we do not expect harm among CR chum or coho from pile driving. Adult salmon would likely experience delayed spawning migration, but would have unimpeded access past the construction areas during intermittent cessation of pile driving, which would occur for an hour or so several times a day, and during the night when all pile driving is ceased. As such, this effect is unlikely result in decreased spawning success, but is likely to result in sublethal effects on adult CR chum salmon and coho through elevated stress.

Noise from vibratory driving and from vessel motors do not have the same pressure or vibration profile in water, and are not observed to cause injury, however fish can detect these sounds and respond with a startle reaction (temporarily raised cortisol, and decreased ability to detect prey and predators) and avoidance behaviors. It is unclear if fish become habituated to this type of noise. These responses are only likely among rearing juvenile salmonids because adult salmonids' instinct to reach natal streams would not be impeded by low level noise of this type.

Predation risk. Both rearing and migrating fish from every population/species could be preyed upon with more frequency in the action area as a result of the new structures. This occurs for two reasons, one being that both shade and piles could provide ambush habitat for predatory fish, and the second is that salmonid vision does not adjust to sharp light/dark contrast well (they cannot see piscivorous fish in shaded areas), and juveniles avoid entering dark areas (schooling in areas just outside of shaded areas or swimming into deeper areas to avoid shade) which makes them

more vulnerable to predators. However, the height of the structure above the water will decrease direct shade, reducing potential predatory habitat. The depth of the water at the end of the structure, where vessels would be moored is 20 to 30 feet deep. Young of the year ocean-type salmonids primarily migrate at depths of less than 25 feet. (Bottom et al, 2008) At these depths, co-occurrence of small, ocean-type fish within shaded predatory habitat will be limited, but not precluded. Because smaller salmonids are typically migrating in depths below 25 feet, we do not anticipate excessive predation on these species, and risk of increased predation will occur more among the six species with lower Columbia rearing behaviors. Upstream migrating adult salmonids use a wider range of depths, and are adept at swimming and avoidance of structures and predation. Adult fish are also too large to be vulnerable to this increased predator presence.

Water Quality - While adult CR chum and coho salmon could be migrating during the work window, they would avoid any effects from turbidity, and exposure to the incremental level of vessel pollutants which could occur among any adult migrating species over the life of the structure is not expected to affect their pre-spawn condition as they rapidly migrate through the action area to return to natal streams.

Turbidity - Jimmycomelately Creek in Sequim Bay (Weston_Solutions, 2006) to predict the potential concentrations of suspended sediment from vibratory pile driving. Total suspended solid (TSS) concentrations from the tug boat propeller wash as it maneuvered the pile driver barge to and from pile locations exceeded 50 to 100 milligrams per liter (mg/L) but generally returned to background levels of 10 mg/L or less within 5 minutes. TSS concentrations associated with activation of the vibratory hammer to loosen the pile from the substrate ranged from 13 to 42 mg/L and averaged 25 mg/L. TSS was sometimes visible in the water column as a 10 to 16 foot diameter plume that extended at least 15 to 20 feet from the actual pulling event. Newcombe and Jenson (1996) analyzed numerous reports on documented fish responses to suspended sediment in streams and estuaries, and identified a scale of effects based on sediment concentration and duration of exposure. Juvenile salmon exposed to suspended sediment concentrations greater than 20 mg/L for several hours begin to experience sublethal physical effects such as reduction in feeding success and minor physiological stress exhibited by coughing and an increased respiration rate. Based on the results of this past study of a similar action, the sediment plume from the proposed vibratory pile driving is not expected to rise to levels that would adversely affect juvenile salmon or steelhead that might be present in the action area. If present, juvenile salmonids and adult eulachon will not be restricted from avoiding the plume (or confined within it) and will be of sufficient size to avoid potential adverse effects from elevated suspended sediments within the plume.

Chemical Pollutants - Juvenile rearing and migrating fish are likely to be exposed to PAHs and chemicals associated with oils and fuels are likely at very low concentrations so that death and injury are not expected as an immediate response, but rather sublethal effects such as diminished prey and predator detection, or future disease could result. Exposure is likely to be brief among migrating juveniles, but more prolonged among rearing juveniles, and it is the rearing populations/species that could therefore experience latent effects both from direct exposure, and from bioaccumulation. However, because this structure will only moor one vessel at a time, we do not expect chemical pollutants to cause direct effects, but rather contribute to cumulative, sublethal effects discussed above.

Reduced Prey – Juvenile fish, both migrating and rearing, need abundant prey to grow and mature for later life stages. Prey reductions could occur in localized areas where sediments are disturbed by in water work, and this source of prey reduction will resolve in several weeks as the area recolonizes from upstream prey communities. Prey reductions from reduced light are expected but because shade effects are somewhat mitigated by structure placement and materials, the loss should be very slight, however are permanent where they occur. Where vessels regularly disturb bottom sediments at the boat launch, prey reductions will occur and probably persist at lower levels because disturbance is frequent. Finally, water quality reduction from vessel fuels, oils and exhaust may cause some reduction in prey availability (abundance and or composition) or prey quality. In response to prey reductions, competition may increase. When prey availability declines, carrying capacity decreases, and territorial behavior increases both in the affected area, and in adjacent areas where fish may go to find additional prey resources, increasing competition. A fixed amount of prey supports a smaller number of larger fish, or a larger number of smaller fish, but because larger fish are more successful at both defending territory, and avoiding predators, declines in prey abundance has greater effects on smaller members of the cohorts exposed, with increased bioenergetics demand, reduced growth, and more susceptibility to predators. Some juvenile salmonids from every population/species could experience this.

Some individual fish from each of the 13 species described in Table 1 are likely to be exposed to the effects of the proposed action, but only sound from pile driving is likely to be at a scale, intensity, or duration that will cause significant adverse response. Based on the location of the proposed action, individuals from all populations of some species are likely to be exposed to effects of the action, while in other species, only individuals from some populations are likely to be exposed (see below for specific populations and species). The proposed impact pile driving is expected to be over an 11 day period between October 1 and December 31. This time range occurs when overall species presence is generally at its lowest, however some species still are present in relatively high abundance for some life stages in portions of that work window. Accordingly, we conduct our analysis as if the project occurs in October, when many species are present, or present with relative abundance, and therefore, potentially exposed to project effects.

Summary of Construction Effects on Listed Species.

Some fish from every species will be present during project construction either as juveniles or adults. Most juvenile salmonids present will be migrating juveniles with limited exposure to the effects of the proposed action, with six juvenile salmonid species likely to have greater exposure based on their rearing behaviors. Only two salmonid species are likely to be present as adults – coho and chum. Based on timing and life history behaviors, only coho are exposed both as rearing juveniles, and as adults.

Most of the fish present will incur short-term stress or other sublethal responses due to interaction with construction equipment, noise, increased energetic costs, and reduced water quality and foraging ability. This stress and other sublethal responses are likely to reduce long-term fitness for some of these fish. A few other fish may die due to the combination of multiple factors, such as the stresses cause by the proposed action combined with a previous stressor unrelated to the proposed action. Any fish in the vicinity of injuries noise levels as discussed above, may be injured or killed. Death and reduced fitness is most likely to cause minimal, reduced abundance in one cohort of each SR fall Chinook, LCR Chinook, Willamette River

Chinook, LCR coho, and two cohorts of LCR steelhead, and Willamette River based on their long freshwater rearing behaviors, and the remaining effects will be indiscernible against other factors affecting abundance and therefore at a low enough level that they are unlikely to influence the rate of juvenile to adult survival for returning adults. Therefore, we do not anticipate any population level consequences to any of the VSP parameters for exposed populations.

2.5 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

Other effects that are likely to occur in the action area that are outside of any federal nexus are related to recreational uses of the Columbia River, which are likely to intensify with increases in human population growth. Effluent discharges from other WWTP plants and industrial areas will also contribute to continued water quality diminishment associated with human population growth. Further water quality diminishment will occur as the landscape in uplands continues to be transformed by intensifying uses (commercial, industrial, and residential). These effects, while certain to occur, are difficult to quantify in any degree.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

Species
All but two of the species affected by the proposed action are considered threatened by the risk of extinction, and the other two are considered endangered by the risk of extinction. All of the species have lower abundance, productivity, spatial structure and diversity than was common in

recent history, and each of the species has both less habitat, and degraded quality of habitat available to them. These conditions contribute to their status, and also to the quality of their designated critical habitat. Impaired baseline conditions in the action area are representative of systemic habitat degradation, and are factors that inhibit the increases in productivity necessary for robust recovery of the species. We add the effects of the proposed action to this context.

The action will add both short term and long term, sublethal and lethal effects to listed species and their habitats. The most acute effects will occur primarily among salmonids that co-occur with pile driving. A small number of fish may be harmed as a result of predation related to shade over the life of the structure. However, as discussed above, we do not expect this effect to result in excessive predation due to depth and height of the structure above the water. Timing of the construction is intended to reduce exposure of vulnerable life stages, and we therefore conclude that fish injured or killed will be at levels low enough that the small reduction in abundance will not be discernible among returns of these cohorts i.e., productivity is unlikely to be appreciably affected for any one population. Therefore, we anticipate neither survival or recovery of the listed species will be affected.

Critical Habitat
The action will result in slight long-term decreases in the conservation value of critical habitat for salmonids. These will include impingements on the migration and rearing PBFs resultant from increased predatory habitat, and minor effects on the forage PBF resultant from shade impacts. When these changes are added to the baseline condition, the function of PBFs are modified at a level that we do not anticipate to be appreciable within the watershed. Since these effects are difficult to distinguish beyond the site scale, we expect that they will not appreciably diminish the conservation role of the watershed in which the site is located.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence LCR Chinook salmon, UWR Chinook salmon, UCR spring-run Chinook salmon, SR spring/summer-run Chinook salmon, SR fall-run Chinook salmon, Columbia River chum salmon, LCR coho salmon, SR sockeye salmon, LCR steelhead, UWR steelhead, MCR steelhead, UCR steelhead, SRB steelhead, Southern green sturgeon, eulachon or destroy or adversely modify designated critical habitat for these species.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating,

feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.8.1 Amount or Extent of Take

Take in the form of harm is often impossible to quantify as a number of individuals, because the presence of the individuals (exposure to the harmful conditions) is highly variable over time, and is influenced by factors that cannot be easily predicted. Additionally the duration of exposure is highly variable based on species behavior patterns, and the wide variability in numbers exposed and duration of exposure create a range of responses, many of which cannot be observed without research and rigorous monitoring. In these circumstances, we describe an "extent" of take which is a measure of the harming condition spatially, temporally, or both. The extent of take is causally related to the amount of harm that will result, and each extent of take provided below is an observable metric for monitoring, compliance, and re-initiation purposes.

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

1. Harm associated with hydroacoustic impacts to salmon and steelhead from driving the piles with an impact hammer: the number cumulative hours of pile driving each day: The extent of take for hydroacoustic effects is a maximum of 12 consecutive hours with a 12 hour delay before resuming each day's pile driving, for a total of 11 days of pile driving. This surrogate is causally linked to incidental take by hydroacoustic impacts because the amount of take increases incrementally with each pile strike and hydroacoustic impacts go back to baseline SELs after a 12 hour delay.
2. Harm associated with increased predation resultant from shading from the structure. The extent of take for shade and predation effects is the completed size of the overwater structure, 1,976 sf.

2.8.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). The Corps and applicant shall minimize incidental take by:

1. Ensuring completion of a monitoring and reporting program for pile driving to confirm that the take exemption for the proposed action is not exceeded, and that the terms and conditions in this incidental take statement are effective in minimizing incidental take.
2. Ensure the completion of a monitoring and reporting program for the completed structure to confirm that the take exemption for the proposed action is not exceeded, and that the terms and conditions in this incidental take statement are effective in minimizing incidental take.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1) The following terms and conditions implement reasonable and prudent measure 1 (Corps protective permit conditions):

   a) Require Specific Timing of In-Water Work.
      i) All piles shall be installed with a vibratory pile driver, except while proofing with an impact hammer.
      ii) Pile driving shall be completed over one in-water work period.
      iii) In-water work (pile driving) in Columbia River shall occur only during the period of October 1 to December 31 work window.
      iv) All work must be completed within these dates.

   c) Require Specific Conditions for Pile Driving.
      i) Steel piles shall not exceed 36-inches in diameter.
      ii) When possible, use a vibratory hammer for pile installation.
      iii) When water depth exceeds 3.28-feet, use a confined bubble curtain or similar sound attenuation system capable of achieving up to 7 dB of sound attenuation during impact pile driving.
      iv) When pile driving, minimize cumulative SELs by delaying pile driving 12 hours after each day of pile driving.

2) The following terms and conditions implement reasonable and prudent measure 2 (monitoring):

   a) Reporting: USACE and the applicant shall monitor and report on the following items, at a minimum:
      i) Pile installation. Report the number of strikes per pile, the number of piles installed, the type of piles installed, the time between pile installation sessions, the total days of pile driving, the type and use of sound attenuation device, and type of driving hammer used.

ii) Overwater structure. Report completed dimensions of the structure to ensure it does not exceed 1,976 sf of overwater coverage.
iii) Submit monitoring reports to NMFS through the following e-mail addresses: projectreports.wcr@noaa.gov with a cc to Scott.Anderson@noaa.gov.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

> Continue to support the recovery of ESA listed species and critical habitat in the Columbia River through restoration efforts such as tree planting, removal of derelict overwater structures, and routine maintenance and cleanup of existing overwater facilities.

2.10 Reinitiation of Consultation

This concludes formal consultation for Port of Kalama Small Cruise Vessel Dock.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.11. "Not Likely to Adversely Affect" Determinations

Southern DPS Green Sturgeon

The only known spawning population of the southern DPS of green sturgeon occurs in the Sacramento River. Adults migrate into the river to spawn between April and July. Juveniles spend 1 to 4 years in freshwater before migrating to the ocean. Evidence of green sturgeon spawning in the coastal estuaries of Washington is lacking and not expected to occur (Adams et al. 2002). Consequently, the proposed action will have no impact on Southern green sturgeon spawning or juvenile rearing.

During the late summer and early fall, subadult and non-spawning adult green sturgeon can frequently be found aggregating in estuaries along the Pacific coast (Moser and Lindley 2007)

with particularly large concentrations occurring in the Columbia River estuary, Willapa Bay, and Grays Harbor (Moyle *et al.* 1992). Adult green sturgeon are common in the seawater and mixing zones of Grays Harbor during high salinity periods, with the highest abundance from July through early October (Monaco *et al.* 1990).

Although non-spawning individuals of this species could be present in the Lower Columbia River during project construction activities, pile installation will occur in a small area compared to the entire Lower Columbia River estuary area.

Green Sturgeon may be affected by turbidity and suspended sediments and/or elevated sound levels. Sturgeon are typically found in turbid conditions and forage in the benthos by stirring up the sediment to access benthic prey such as burrowing shrimp and are thus relatively tolerant of higher suspended sediment concentrations.

The only impact on green sturgeon would be a slight decrease in prey resources. However, this decrease is not expected to result in harm on any individual green sturgeon.

Adults and subadults are strong swimmers with the speed and power to escape and avoid noise and disturbance from pile driving activities.

Therefore, the project is not likely to adversely affect green sturgeon.

Eulachon

The Southern DPS includes those eulachon originating from the Skeena River in British Columbia south to and including the Mad River in northern California (NOAA 2014); eulachon originating from the Nass river and further north comprise at least one additional DPS (NOAA 2010). The Southern DPS was originally listed as threatened on March 18, 2010 (Gustafson et al, 2010). The action area is within designated critical habitat of eulachon.

Eulachon, also known as Pacific smelt, candlefish, or Columbia River smelt, are small oceangoing fish that occur in offshore marine waters and return to tidal portions of rivers to spawn. Adults do not feed while in freshwater (WDFW and ODFW 2001).

Because eulachon do not have swim bladders, elevated noise from pile driving is not known to cause harm to eulachon. Further, the structure will not impede adult migration or impact eulachon eggs that could be drifting or settling in sediment around the structure.

The likelihood of construction and presence of the small cruise vessel dock causing a measurable impact to the eulachon southern DPS is negligible.

The project is not likely to adversely affect eulachon or their designated critical habitat.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast salmon (PFMC 2014); contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The proposed action and action area are described in the Introduction of this document. The action area is designated as EFH for various life-history stages of Chinook salmon (*O. tshawytscha*) and coho salmon (*O. kisutch*).

3.2 Adverse Effects on Essential Fish Habitat

These effects are described more fully in Section 2 of this document.

3.3 Essential Fish Habitat Conservation Recommendations

Fully implementing the EFH conservation recommendations described in this section would protect, by avoiding or minimizing the adverse effects described in Section 3.2, above, approximately 1 acre of designated EFH for Pacific Coast salmon:

1. Take care when removing piles to minimize bed disturbance and suspended sediments.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a

response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps. Other interested users could include the Port of Kalama, and stakeholders from Cowlitz County, or interest groups such as American Rivers or American Audubon. Individual copies of this opinion were provided to the Corps. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion [*and EFH consultation, if applicable*] contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA [*and MSA implementation, if applicable*], and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. REFERENCES

Abatzoglou, J.T. Rupp, D.E. and Mote, P.W. 2014. Seasonal climate variability and change in the pacific northwest of the United States. Journal of Climate 27(5): 2125-2142.

D. L. Bottom , G. Anderson , A. Baptista , J. Burke , M. Burla , M. Bhuthimethee , L. Campbell , E. Casillas , S. Hinton , K. Jacobson , D. Jay , R. McNatt , R. Moran , G. C. Roegner , C. A. Simenstad , V. Stamatiou , D. Teel , and J. E. Zamon . 2008. Salmon life histories, habitat, and food webs in the Columbia River estuary: an overview of research results, 2002–2006. Report prepared for the U.S. Army Corps of Engineers, Northwest Division, Portland District, Contract W66QKZ 7007 8056, and Bonneville Power Administration, Environment, Fish, and Wildlife Division, Portland, Oregon.

Crozier, L.G., Hendry, A.P., Lawson, P.W., Quinn, T.P., Mantua, N.J., Battin, J., Shaw, R.G. and Huey, R.B., 2008. Potential responses to climate change in organisms with complex life histories: evolution and plasticity in Pacific salmon. Evolutionary Applications 1(2): 252- 270.

Crozier, L. G., M. D. Scheuerell, and E. W. Zabel. 2011. Using Time Series Analysis to Characterize Evolutionary and Plastic Responses to Environmental Change: A Case Study of a Shift Toward Earlier Migration Date in Sockeye Salmon. The American Naturalist 178 (6): 755-773.

EPA (U.S. Environmental Protection Agency). 2014. 2013-2014 National River and Streams Assessment Fish Tissue Study. HTTPS:// WWW.EPA.GOV/Fish-Tech/2013-2014 National Rivers and Streams Assessment Fish Tissue Study. Access 11/2/2020

Dominguez, F., E. Rivera, D. P. Lettenmaier, and C. L. Castro. 2012. Changes in Winter Precipitation Extremes for the Western United States under a Warmer Climate as Simulated by Regional Climate Models. Geophysical Research Letters 39(5).

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. Annual Review of Marine Science 4: 11-37.

Feely, R.A., T. Klinger, J.A. Newton, and M. Chadsey (editors). 2012. Scientific summary of ocean acidification in Washington state marine waters. NOAA Office of Oceanic and Atmospheric Research Special Report.

Glick, P. Clough J., and B. Nunley. 2007. Sea-Level Rise and Coastal Habitats in the Pacific Northwest: An analysis for Puget Sound, southwestern Washington, and northwestern Oregon. National Wildlife Federation, Seattle, WA.

Goode, J.R., Buffington, J.M., Tonina, D., Isaak, D.J., Thurow, R.F., Wenger, S., Nagel, D., Luce, C., Tetzlaff, D. and Soulsby, C., 2013. Potential effects of climate change on streambed scour and risks to salmonid s rvival in snow-dominated mountain basins. Hydrological Processes 27(5): 750-765.

Gustafson, R.G., M.J. Ford, D. Teel, and J.S. Drake. 2010. Status review of eulachon (*Thaleichthys pacificus*) in Washington, Oregon, and California. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-105, 360 p

Isaak, D.J., Wollrab, S., Horan, D. and Chandler, G., 2012. Climate change effects on stream and river temperatures across the northwest US from 1980–2009 and implications for salmonid fishes. Climatic Change 113(2): 499-524.

IPCC 2014 Summary for policymakers In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change ed C B Field et al (Cambridge)(Cambridge University Press)(Cambridge, United Kingdom and New York, NY, USA) pp 1–32

ISAB (editor). 2007. Climate change impacts on Columbia River Basin fish and wildlife. In: Climate Change Report, ISAB 2007-2. Independent Scientific Advisory Board, Northwest Power and Conservation Council. Portland, Oregon.

Kidd, K.A., P.J. Blanchfield, K.H. Mills, V.P. Palace, R.E. Evans, J.M. Lazorchak and R.W. Flick. 2007. Collapse of a fish population after exposure to a synthetic estrogen. Proceedings of the National Academy of Sciences 104(21):8897-8901.

Kunkel, K. E., L. E. Stevens, S. E. Stevens, L. Sun, E. Janssen, D. Wuebbles, K. T. Redmond, and J. G. Dobson. 2013. Regional Climate Trends and Scenarios for the U.S. National Climate Assessment: Part 6. Climate of the Northwest U.S. NOAA Technical Report NESDIS 142-6. 83 pp. National Oceanic and Atmospheric Administration, National Environmental Satellite, Data, and Information Service, Washington, D.C.

Lawson, P. W., Logerwell, E. A., Mantua, N. J., Francis, R. C., & Agostini, V. N. 2004. Environmental factors influencing freshwater survival and smolt production in Pacific Northwest coho salmon (Oncorhynchus kisutch). Canadian Journal of Fisheries and Aquatic Sciences 61(3): 360-373.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. In The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, edited by M. M. Elsner, J. Littell, L. Whitely Binder, 217-253. The Climate Impacts Group, University of Washington, Seattle, Washington.

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate change impacts on streamflow extremes and summertime stream temperature and their possible consequences for freshwater salmon habitat in Washington State. Climatic Change 102(1): 187-223.

McMahon, T.E., and G.F. Hartman. 1989. Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon (Oncorhynchus kisutch). Canadian Journal of Fisheries and Aquatic Sciences 46: 1551–1557.

Meyer, J.L., M.J. Sale, P.J. Mulholland, and N.L. Poff. 1999. Impacts of climate change on aquatic ecosystem functioning and health. JAWRA Journal of the American Water Resources Association 35(6): 1373-1386.

Moser, M., and S. Lindley. 2007. Use of Washington estuaries by subadult and adult green sturgeon. Environmental Biology of Fishes 79:243-253.

Mote, P.W., Dalton, M., Snover, A.K. 2013. Climate Change in the Northwest: Implications for our Landscapes, Waters, and Communities. Washington, D.C.: Island Press. 271 pp.

Mote, P.W, A. K. Snover, S. Capalbo, S.D. Eigenbrode, P. Glick, J. Littell, R.R. Raymondi, and W.S. Reeder. 2014. Ch. 21: Northwest. In Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, T.C. Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Program, 487-513.

Mote, P.W., D.E. Rupp, S. Li, D.J. Sharp, F. Otto, P.F. Uhe, M. Xiao, D.P. Lettenmaier, H. Cullen, and M. R. Allen. 2016. Perspectives on the cause of exceptionally low 2015 snowpack in the western United States, Geophysical Research Letters, 43, doi:10.1002/2016GLO69665

Moyle PB, Foley PJ, Yoshiyama RM (1994) Status and biology of the green sturgeon, Acipenser medirostris. Sturgeon Quarter 2:7

Northwest Fisheries Science Center. 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest.

Newcombe C. P. and J. O. T. Jensen. 1996. Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Management. 16: 693-727.

Olla, B.L. Davis, M.W. Schreck, C.C. 1995. Stress-induced impairment of predator evasion and non-predator mortality in Pacific salmon. Journal of Aquatic Research, Volume 26 Issue 6. June 1995.

PFMC (Pacific Fishery Management Council). 1998. Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan. Appendix D to Amendment 8 to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council, Portland, Oregon. December.

PFMC. 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon.

PFMC. 2007. U.S. West Coast highly migratory species: Life history accounts and essential fish habitat descriptions. Appendix F to the Fishery Management Plan for the U.S. West Coast Fisheries for Highly Migratory Species. Pacific Fishery Management Council, Portland, Oregon. January.

PFMC. 2005. Amendment 18 (bycatch mitigation program), Amendment 19 (essential fish habitat) to the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery. Pacific Fishery Management Council, Portland, Oregon. November.

PFMC. 2008. Management of krill as an essential component of the California Current ecosystem. Amendment 12 to the Coastal Pelagic Species Fishery Management Plan. Environmental assessment, regulatory impact review & regulatory flexibility analysis. Pacific Fishery Management Council, Portland, Oregon. February.

Raymondi, R.R., J.E. Cuhaciyan, P. Glick, S.M. Capalbo, L.L. Houston, S.L. Shafer, and O. Grah. 2013. Water Resources: Implications of Changes in Temperature and Precipitation. In Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edited by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.

Reeder W.S., P.R. Ruggiero, S.L. Shafer, A.K. Snover, L.L Houston, P. Glick, J.A. Newton, and S.M Capalbo. 2013. Coasts: Complex Changes Affecting the Northwest's Diverse Shorelines. In Climate Change in the Northwest: Implications for Our Landscapes, Waters, and Communities, edi ed by M.M. Dalton, P.W. Mote, and A.K. Snover, 41-58. Island Press, Washington, DC.

Rich, W.H. 1920. Early history and seaward migratiaon of Chinook salmon in the Columbia and Sacramento Rivers. Bulletin of the Bureau of Fisheries. Vol XXXVII, Doc. No. 887. July 26, 1920.

Rodkin, R. and K. Pommerenck. 2014. Caltrans compendium of underwater sound data from pile driving-2014 update. In INTER-NOISE and NOISE-CON Congress and Conference Proceedings (Vol. 249, No. 3, pp. 4507-4605). Institute of Noise Control Engineering.

Scheuerell, M.D., and J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (Oncorhynchus tshawytscha). Fisheries Oceanography 14:448-457.

Stadler, John. 2019. National Marine Fisheries Service. Personal Communication. May 18, 2019.

Sunda, W. G., and W. J. Cai. 2012. Eutrophication induced CO2-acidification of subsurface coastal waters: interactive effects of temperature, salinity, and atmospheric p CO2. Environmental Science & Technology, 46(19): 10651-10659

Tague, C. L., Choate, J. S., & Grant, G. 2013. Parameterizing sub-surface drainage with geology to improve modeling streamflow responses to climate in data limited environments. Hydrology and Earth System Sciences 17(1): 341-354

Tillmann, P., and D. Siemann. 2011. Climate Change Effects and Adaptation Approaches in Marine and Coastal Ecosystems of the North Pacific Landscape Conservation Cooperative Region. National Wildlife Federation.

Wainwright, T. C., and L. A. Weitkamp. 2013. Effects of climate change on Oregon Coast coho salmon: habitat and life-cycle interactions. Northwest Science 87(3): 219-242

WDFW and ODFW (2001). Joint state eulachon management plan (Washington Department of Fish and Wildlife and Oregon Department of Fish and Wildlife).

Winder, M., and Schindler, D.E. (2004). Climate change uncouples trophic interactions in an aquatic ecosystem. Ecology *85*, 2100-2106.

Zabel, R.W., M.D. Scheuerell, M.M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1):190-200

APPENDIX 1

Presence of ESA-listed fish species in the Lower Columbia River by life stage, NMFS' Northwest Fisheries Science Center, and NMFS' Protected Resources Division. Work window months depicted by orange highlight.

		=present								= relatively abundant								= peak occurrence							
Species	**Life Stage**	**Jan**		**Feb**		**Mar**		**Apr**		**May**		**Jun**		**Jul**		**Aug**		**Sep**		**Oct**		**Nov**		**Dec**	
Salmon: Chinook																									
Lower	Adult migr. & holding																								
Columbia	Adult spawning																								
	Eggs & pre-emergence																								
	Juvenile rearing																								
	Juvenile emigration																								
Upper	Adult migr. & holding																								
Columbia	Adult spawning																								
	Eggs & pre-emergence																								
	Juvenile rearing																								
	Juvenile emigration																								
Upper	Adult migr. & holding																								
Willamette	Adult spawning																								
	Eggs & pre-emergence																								
	Juvenile rearing																								
	Juvenile emigration																								
Snake River -	Adult migr. & holding																								
Sprng/Summr	Adult spawning																								
	Eggs & pre-emergence																								
	Juvenile rearing																								
	Juvenile emigration																								
Snake River -	Adult migr. & holding																								
Fall	Adult spawning																								
	Eggs & pre-emergence																								
	Juvenile rearing																								
	Juvenile emigration																								

			=present								=·relatively·abundant								=·peak·occurrence							
Species	**Life·Stage**	**Jan**		**Feb**		**Mar**		**Apr**		**May**		**Jun**		**Jul**		**Aug**		**Sep**		**Oct**		**Nov**		**Dec**	
Salmon:·Chum·¶																									
Columbia·	Adult·migration.·&·holding·																								
River	Adult·spawning																								
	Eggs·&·pre-emergence																								
	Juvenile·rearing																								
	Juvenile·emigration[4]																								
Salmon:·Coho·¶																									
Lower·	Adult·migration.·&·holding·																								
Columbia	Adult·spawning																								
	Eggs·&·pre-emergence																								
	Juvenile·rearing																								
	Juvenile·emigration																								
Salmon:·Sockeye¶																									
Snake·River	Adult·migration.·&·holding·																								
	Adult·spawning																								
	Eggs·&·pre-emergence																								
	Juvenile·rearing																								
	Juvenile·emigration																								
Steelhead																									
Lower·	Adult·migration.·&·holding·																								
Columbia	Adult·spawning																								
	Eggs·&·pre-emergence																								
	Juvenile·rearing																								
	Juvenile·emigration																								
Middle·	Adult·migration.·&·holding·																								
Columbia	Adult·spawning																								
	Eggs·&·pre-emergence																								
	Juvenile·rearing																								
	Juvenile·emigration																								
Upper·	Adult·migration.·&·holding·																								
Columbia	Adult·spawning																								
	Juvenile·rearing																								
	Juvenile·emigration																								

			=present								=·relatively·abundant								=·peak·occurrence							
Species	**Life·Stage**	**Jan**		**Feb**		**Mar**		**Apr**		**May**		**Jun**		**Jul**		**Aug**		**Sep**		**Oct**		**Nov**		**Dec**	
■ Snake·River	Adult·migration.·&·holding·																								
■	Adult·spawning																								
■	Eggs·&·pre-emergence																								
■	Juvenile·rearing																								
■	Juvenile·emigration																								
■																									

Carter·et·al.·2009·(Seasonal·juvenile·salmonid·presence·and·migratory·behavior·in·the·lower·Columbia·River).·